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An experimental study on channel type shear connectors

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ABSTRACT

This paper describes an experimental study on European channel shear connectors. While shear studs are widely used in steel–concrete composite elements, the channel connectors are also gaining popularity due to their certain advantages. The channel connectors do not require special equipment and standard welding procedures are adequate for attachment purposes. In addition, this type of connector offers higher amounts of shear resistance due to its high contact area with surrounding concrete. Although first studies date back to 1950s, little work has been done in the past to investigate their behavior. Majority of the work done to date was on channel connectors used in North America with a very limited parameter range. An experimental study consisting of 15 push-out tests was carried out to investigate the behavior of European type channel connectors with various heights and lengths. The ultimate resistance of the connectors obtained from experiments was compared against those predicted by North American steel design specifications. It was observed that the equations presented in American and Canadian specifications are too conservative. Based on a model that represents the typical failure mechanism in push-out tests, a new equation was developed for the ultimate resistance of channel shear connectors. It is shown that the developed equation is capable of predicting the ultimate resistance of channel connectors with reasonable accuracy.

1. Introduction

Steel–concrete composite structural systems are widely used in buildings and bridges around the world. This kind of a structural system utilizes the advantages of steel and concrete. The most general form of such a system is the composite flexural members that are formed by connecting steel beams and a concrete slab by making use of shear connectors. A composite flexural member will have higher strength and stiffness compared to a bare steel member, resulting in reduced deflection and floor vibration in the structure. Composite flexural members can be used as girders in bridges or primary and secondary beams in building systems. Mechanical connectors for shear transfer must be used in these members to achieve the desired composite behavior. The shear connectors are placed at the interface between steel beam and concrete slab, and they are responsible for transferring the horizontal shear forces that are formed due to flexural action. The need for mechanical shear connectors also arises to transfer earthquake forces between concrete slab and steel beams that are part of the lateral load resisting system of the structure. Besides, these elements function under axial loads to resist vertical upward forces and prevent the premature separation of steel beams and concrete slab in the vertical direction.

Even though the most common type of shear connectors is the welded headed shear stud, another alternative, namely channel shear connector, has been the subject of recent research. Headed shear studs are welded to steel beams by making use of a special welding equipment that requires high voltage for operation. In addition, shear capacity provided by a typical shear stud is limited due to the low contact area with concrete. In some designs, large number of shear studs is needed to safely transfer the amount of lateral forces required for a full composite action or those produced during seismic actions. In these cases engineers are faced with the difficulty of placing the sufficient number of shear studs on the steel beams. Channel shear connectors, on the other hand, are welded on steel beams using conventional welding equipment, and using these connectors give the designer the freedom of sizing the connector to have the required force capacity with less number of connectors than headed studs. An example of the use of channel shear connectors in a composite bridge superstructure is shown in Fig. 1.

The research on channel shear connectors dates back to the push-out tests reported by Viest et al. in 1952 [1]. This document provides valuable information regarding the behavior of channel shear connectors embedded in concrete blocks. The relation between the flexural behavior of composite beam specimens and that of individual shear connectors was investigated by Slutter and Driscoll [2]. Based on the push-out test results reported by Viest et al. [1], Slutter and Driscoll [2] suggested an empirical equation to predict the ultimate strength of channel shear connectors. This expression was later modified to be able to use it with light-weight concrete, and presented in the

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